



# **S**mall **B**usiness **I**nnovation **R**esearch **S**mall Business **T**echnology **T**Ransfer

**Finding Opportunities  
within the NASA Mission Directorates**

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**April 5, 2017**

# Aeronautics Research Mission Directorate (ARMD)



- NASA's Aeronautics Research Mission Directorate (ARMD) expands the boundaries of aeronautical knowledge for the benefit of the Nation and the broad aeronautics community, which includes the Agency's partners in academia, industry, and other government agencies.
- ARMD is conducting high-quality, cutting-edge research that will lead to revolutionary concepts, technologies, and capabilities that enable radical change to both the airspace system and the aircrafts that fly within it, facilitating a safer, more environmentally friendly, and more efficient air transportation system.
- At the same time, we are ensuring that aeronautics research and critical core competencies continue to play a vital role in support of NASA's goals for both manned and robotic space exploration.

<https://www.nasa.gov/aeroresearch>

# NASA Aeronautics – 6 Strategic Thrusts



## **Safe, Efficient Growth in Global Operations**

- Enable full NextGen and develop technologies to substantially reduce aircraft safety risks



## **Innovation in Commercial Supersonic Aircraft**

- Achieve a low-boom standard



## **Ultra-Efficient Commercial Vehicles**

- Pioneer technologies for big leaps in efficiency and environmental performance



## **Transition to Low-Carbon Propulsion**

- Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology



## **Real-Time System-Wide Safety Assurance**

- Develop an integrated prototype of a real-time safety monitoring and assurance system



## **Assured Autonomy for Aviation Transformation**

- Develop high impact aviation autonomy applications



# Aeronautics Programs



## Advanced Air Vehicle Program

Innovative design concepts developed by AAVP for advanced vehicles integrate multiple, simultaneous vehicle performance considerations that focus on fuel burn, noise, emissions and intrinsic safety. The goal: to enable new aircraft to fly safer, faster, cleaner, quieter, and use fuel far more efficiently.



The goal of AOSP-developed NextGen methods and means is to provide advanced levels of automated support to air navigation service providers and aircraft operators for reduced air travel times and air travel-related delays, and to insure greater safety in all weather conditions. By moving key concepts and technologies from the laboratory into the field, AOSP helps to make air travel as safe and efficient as possible – today as well as tomorrow – to directly benefit the flying public.



Cultivates multi-disciplinary, revolutionary concepts to enable aviation transformation. Focus is on sharply focused research, and also provides flexibility for innovators to explore technology feasibility and provide the knowledge base for radical transformation.







# ARMD Programs with Strategic Thrusts

## Mission Programs

### Airspace Operations and Safety Program (AOSP)

- Safe, Efficient Growth in Global Operations
- Real-Time System-Wide Safety Assurance
- Assured Autonomy for Aviation Transformation



### Advanced Air Vehicles Program (AAVP)

- Ultra-Efficient Commercial Vehicles
- Innovation in Commercial Supersonic Aircraft
- Transition to Low-Carbon Propulsion
- Assured Autonomy for Aviation Transformation (future)



### Integrated Aviation Systems Program (IASP)

- Flight Research-Oriented Integrated, System-Level R&T supporting all six thrusts
- X-Planes/Test Environment



## Seedling Program

### Transformative Aeronautics Concepts Program (TAC)

- High-risk, leap-frog ideas supporting all six thrusts
- Critical cross-cutting tool and technology development
- Assured Autonomy for Aviation Transformation



# Human Exploration Mission Directorate (HOEMD)



- The Human Exploration and Operations (HEO) Mission Directorate provides the Agency with leadership and management of NASA space operations related to human exploration in and beyond low-Earth orbit.
- HEO also oversees low-level requirements development, policy, and programmatic oversight.
- The International Space Station, currently orbiting the Earth with a crew of six, represents the NASA exploration activities in low-Earth orbit. Exploration activities beyond low-Earth orbit include the management of Commercial Space Transportation, Exploration Systems Development, Human Space Flight Capabilities, Advanced Exploration Systems, and Space Life Sciences Research & Applications.
- The directorate is similarly responsible for Agency leadership and management of NASA space operations related to Launch Services, Space Transportation, and Space Communications in support of both human and robotic exploration programs.

<https://www.nasa.gov/directorates/heo>

# Exploration Education and Outreach



The Human Exploration and Operations (HEO) Mission Directorate is responsible for NASA's human spaceflight activities. In addition to space station operations, space communication and launch services, HEO is responsible for developing new capabilities that will pave the way for the next generation of human explorers.

HEO is dedicated to informing and educating the public about NASA's plans for a new era in space exploration: using the International Space Station for research and exploration activities in low Earth orbit, fostering a commercial industry and focusing our energy and resources on sending astronauts to an asteroid and eventually to Mars. A variety of educational materials are available to educators who want to invite NASA into their classrooms. Many of these resources can be downloaded in minutes — and at no cost



## [Space Launch Systems Education and Outreach](#)



**Space Station for Researchers** Discover how NASA partners with industry, academia and federal, state, regional and local entities for research and development.



## [Space Life Sciences Education](#)

Welcome to the Space Life Sciences education website! Here you will find resources on living organisms in the space environment. Visit the topic sections for more information, and return to the website often for news on space life sciences research. <https://www.nasa.gov/audience/foreducators/spacelife/home/index.html>



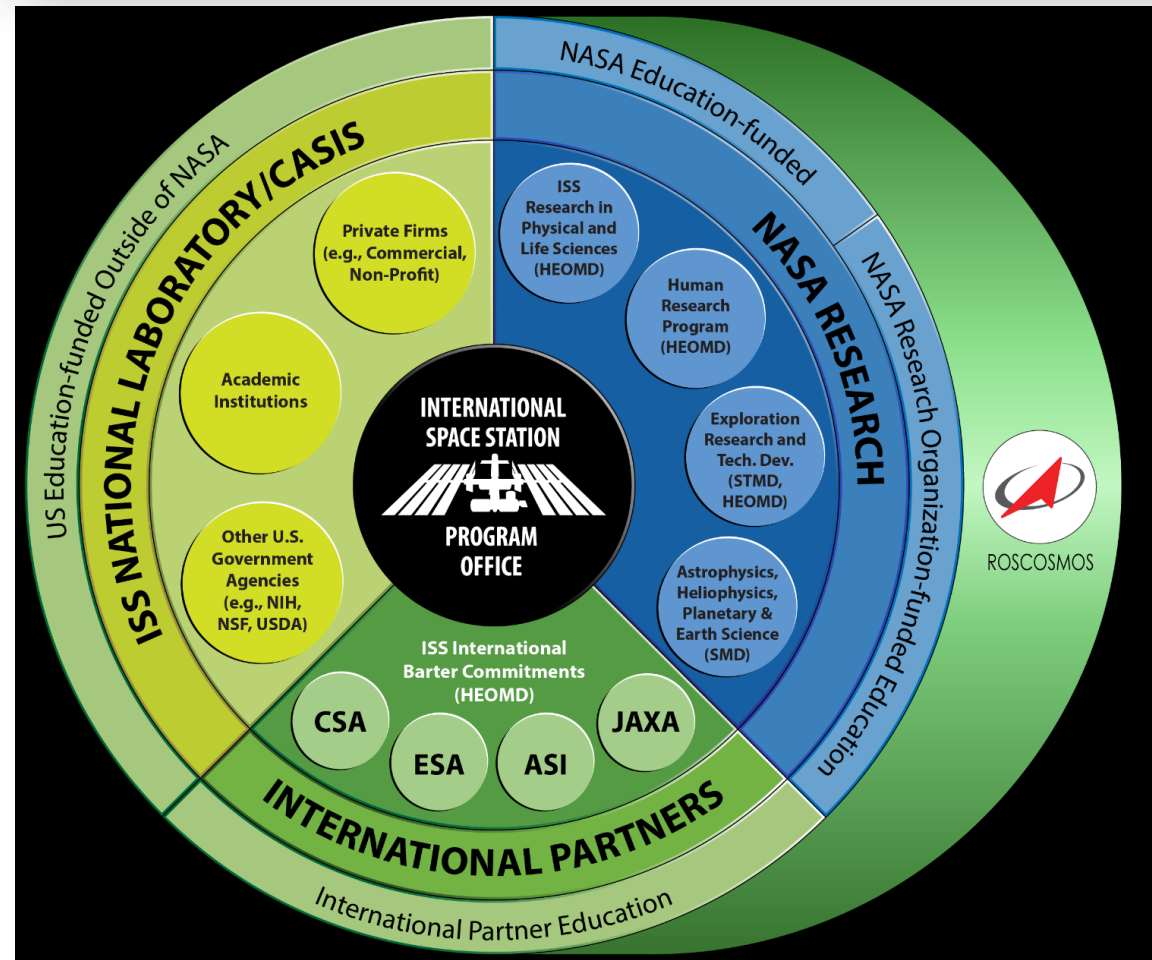
## **International Space Station for [Students](#)**

[https://www.nasa.gov/mission\\_pages/station/research/ops/research\\_student.html](https://www.nasa.gov/mission_pages/station/research/ops/research_student.html) **and**

**[Teachers](#)** [https://www.nasa.gov/mission\\_pages/station/research/ops/research\\_teacher.html](https://www.nasa.gov/mission_pages/station/research/ops/research_teacher.html)



# Funding Sources



For more information on research sponsorship and funding, see:  
[http://www.nasa.gov/mission\\_pages/station/research/ops/funding/](http://www.nasa.gov/mission_pages/station/research/ops/funding/)

## (a) NASA Research

Grant opportunities and information in NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) at

<http://nspires.nasaprs.com/external/>

## (b) National Laboratory Research / The Center for the Advancement of Space in Science (CASIS)

The 2005 NASA Authorization Act designated the U.S segment of the space station as a national laboratory, enabling access by other Federal agencies, non-profits, and the private sector. Opportunities and information in CASIS' website at [www.iss-casis.org/](http://www.iss-casis.org/) and

[www.spacestationresearch.com/research-on-station/opportunities/](http://www.spacestationresearch.com/research-on-station/opportunities/)

## (c) Educational Activities

Both NASA Education and CASIS offer education opportunities and information at NASA:

[www.nasa.gov/audience/foreducators/stem\\_on\\_station/index.html](http://www.nasa.gov/audience/foreducators/stem_on_station/index.html). and at CASIS: <http://www.iss-casis.org/research.php>, <http://iss-casis.org/Education.aspx>, <http://casisacademy.org/>

## (d) International Partner Research

International investigators should seek sponsorship through their appropriate space agency.

# Human Research Program



## Space Biology Research

What science does NASA need to conduct? The National Research Council outlined scientific research recommendations in the publication, Strategy for Space Biology and Medicine in the New Century (1998), calling for NASA's space biology research to take, "an integrated multidisciplinary approach that encompasses all levels of biological organization... from molecules to cells to tissues to organs to systems to whole organisms, and employs the full range of modern experimental approaches."

NASA Space Biology Goals are to:

- Effectively use microgravity and other space environment characteristics to enhance our understanding of the adaptation and function of basic biological processes in spaceflight
- Develop a scientific and technological knowledge base that will contribute to a safe, productive human presence in space during exploration
- Apply this knowledge and technology to improve our nation's competitiveness, education, and the quality of life on Earth.

## Biophysics

### **Biological Macromolecules | Biomaterials | Biological Physics | Fluids of Biology**

In the International Space Station laboratory, NASA grows more perfect biological macromolecules crystals and analyzes them using a method known as diffraction. Diffraction aims beams of light or particles at the crystals and then studies the scattering pattern to determine the structure of the molecules that form them.

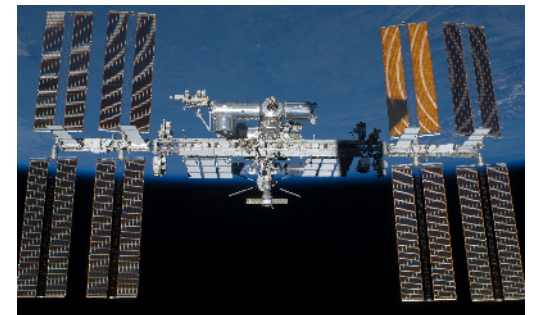
<https://www.nasa.gov/content/physical-sciences-research-program>



# Opportunities to work with HEOMD



- [www.nasa.gov/directorates/heo/index.html](http://www.nasa.gov/directorates/heo/index.html)
- Programs
  - Space Launch System
  - Orion Spacecraft
  - Ground Systems Development
  - Advanced Exploration Systems
  - Space Life and Physical Sciences Research and Applications
  - Human Research Program
  - International Space Station
  - Launch Services
  - Space Communications and Navigation (SCaN)





# Space Technology Mission Directorate (STMD)



- The Space Technology Mission Directorate (STMD) enables a new class of missions by drawing on talent from the NASA workforce, academia, small businesses, and the broader space enterprise to deliver innovative solutions that dramatically improve technological capabilities for NASA and the Nation.
- The rapid development and infusion of new technologies and capabilities are critical components to advancing the Nation's future in space. These activities fuel an emerging aerospace economy and build upon the space technology needs of other government agencies, as well as the overall aerospace enterprise.
- NASA supports these objectives and contributes to the demands of larger national technology goals by investing in Space Technology.

<https://www.nasa.gov/directorates/spacetech/home>

# NASA's Technology Roadmaps



<b>TA 1</b>		<b>LAUNCH PROPULSION SYSTEMS</b>	<b>TA 9</b>		<b>ENTRY, DESCENT, AND LANDING SYSTEMS</b>
<b>TA 2</b>		<b>IN-SPACE PROPULSION TECHNOLOGIES</b>	<b>TA 10</b>		<b>NANOTECHNOLOGY</b>
<b>TA 3</b>		<b>SPACE POWER AND ENERGY STORAGE</b>	<b>TA 11</b>		<b>MODELING, SIMULATION, INFORMATION TECHNOLOGY, AND PROCESSING</b>
<b>TA 4</b>		<b>ROBOTICS AND AUTONOMOUS SYSTEMS</b>	<b>TA 12</b>		<b>MATERIALS, STRUCTURES, MECHANICAL SYSTEMS, AND MANUFACTURING</b>
<b>TA 5</b>		<b>COMMUNICATIONS, NAVIGATION, AND ORBITAL DEBRIS TRACKING AND CHARACTERIZATION SYSTEMS</b>	<b>TA 13</b>		<b>GROUND AND LAUNCH SYSTEMS</b>
<b>TA 6</b>		<b>HUMAN HEALTH, LIFE SUPPORT, AND HABITATION SYSTEMS</b>	<b>TA 14</b>		<b>THERMAL MANAGEMENT SYSTEMS</b>
<b>TA 7</b>		<b>HUMAN EXPLORATION DESTINATION SYSTEMS</b>	<b>TA 15</b>		<b>AERONAUTICS</b>
<b>TA 8</b>		<b>SCIENCE INSTRUMENTS, OBSERVATORIES, AND SENSOR SYSTEMS</b>			

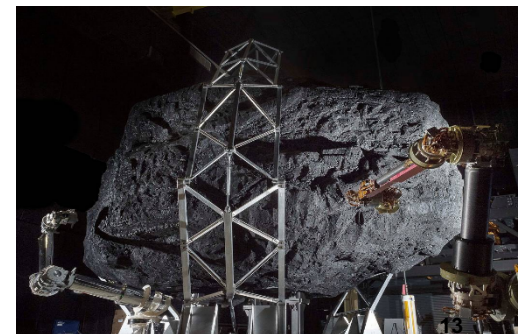
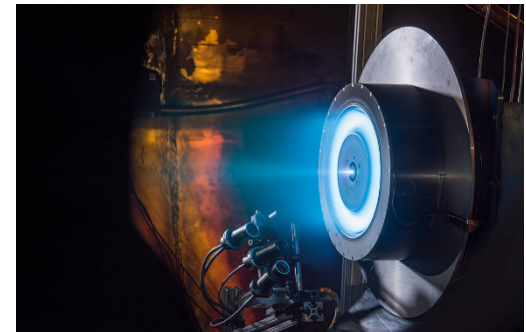
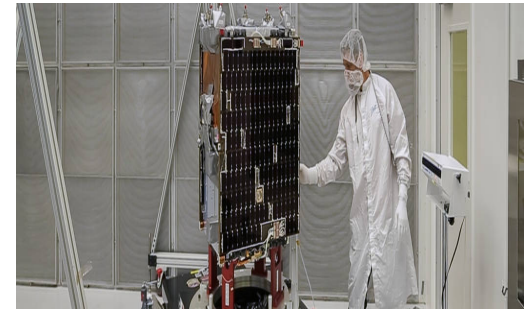
<https://www.nasa.gov/offices/oct/home/roadmaps/index.html>



# Opportunities to work with STMD



- <https://www.nasa.gov/directorates/spacetech/home/index.html>
- Programs
  - Centennial Challenges
  - Center Innovation Fund
  - Flight Opportunities
  - Game Changing Development (GCD)
  - NASA Innovative Advanced Concepts (NIAC)
  - Prizes and Challenges
  - Regional Economic Development
  - SBIR/STTR
  - Small Spacecraft Technology Program
  - Space Technology Research Grants
  - Technology Demonstration Program
  - Technology Transfer





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**Claudia Meyer,**  
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# January 2017



# Space Technology Research Grants

## *Opportunities to Propose*



**Engage Academia:** *tap into **spectrum** of academic researchers, from graduate students to senior faculty members, to examine the theoretical feasibility of ideas and approaches that are critical to making science, space travel, and exploration more effective, affordable, and sustainable.*



### NASA Space Technology Research Fellowships

- Graduate student research in space technology; research conducted on campuses and at NASA Centers and not-for-profit R&D labs



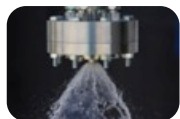
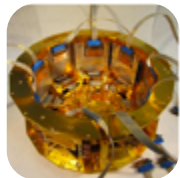
### Early Career Faculty

- Focused on supporting outstanding faculty researchers early in their careers as they conduct space technology research of high priority to NASA's Mission Directorates

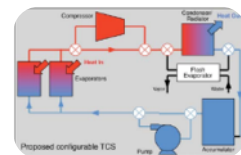
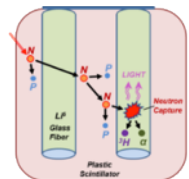
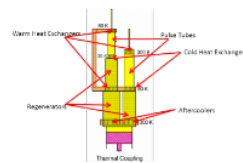
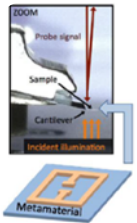


### Early Stage Innovations

- University-led, possibly multiple investigator, efforts on early-stage space technology research of high priority to NASA's Mission Directorates
- Paid teaming with other universities, industry and non-profits permitted



***Reinvigorate the pipeline of high-risk/high-payoff  
low-TRL space technologies***



# STRG Opportunities to Propose NSTRF



## Eligibility Requirements for NSTRF17

1. Pursuing or seeking to pursue advanced degrees directly related to space technology.
2. Are U.S. citizens or permanent residents of the U.S.
3. Are or will be enrolled in a full-time master's or doctoral degree program at an accredited U.S. university in fall 2017.
4. Are early in their graduate careers.

## Application Components

- |   |  |   |                                    |
|---|--|---|------------------------------------|
| 1 | Proposal Cover Page<br>(Program Specific Data Questions) | 5 | Curriculum Vitae                   |
| 2 | Personal Statement                                       | 6 | Transcripts                        |
| 3 | Project Narrative  | 7 | GRE General Test Scores            |
| 4 | Degree Program<br>Schedule                               | 8 | Three Letters of<br>Recommendation |

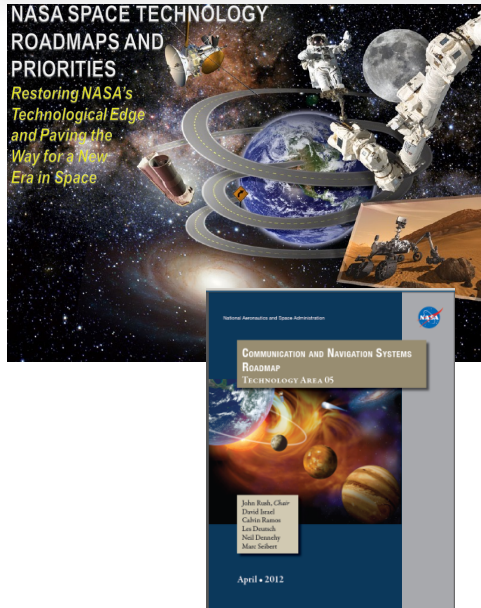
## Award Value

Fellowship Budget Category	Max value
Student Stipend	\$36,000
Faculty Advisor Allowance	\$10,000
Visiting Technologist Experience Allowance	\$10,000
Health Insurance Allowance	\$1,000
Tuition and Fees Allowance	\$17,000
<b>TOTAL</b>	<b>\$74,000</b>

NSTRF17: <http://tinyurl.com/NSTRF2017>.  
NSTRF16: <http://tinyurl.com/NSTRF2016>.  
NSTRF15: <http://tinyurl.com/NSTRF2015>.  
NSTRF14: <http://tinyurl.com/NSTRF14>.  
NSTRF13: <http://tinyurl.com/NSTRF13>.  
NSTRF12: <http://tinyurl.com/NSTRF12-OCT>.  
NSTRF11: <http://tinyurl.com/NSTRF11-OCT>.



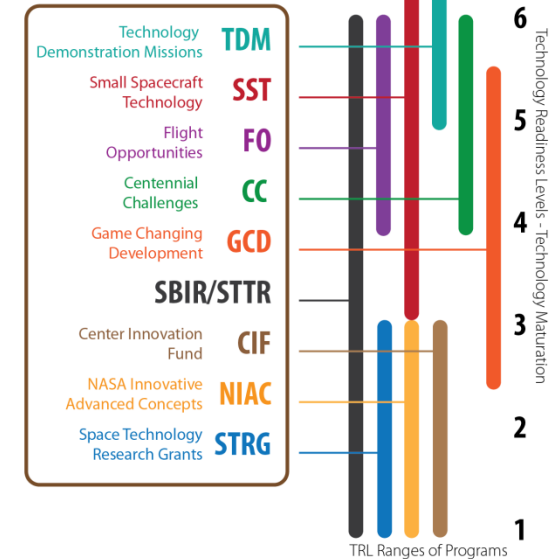
# STRG Opportunities to Propose *ECF and ESI*



## Technical Characteristics:

- Unique, disruptive or transformational space technologies
- Low TRL
- Specific topics tied to Technology Area Roadmaps
- Big impact at the system level: performance, weight, cost, reliability, operational simplicity or other figures of merit associated with space flight hardware or missions

## Space Technology Mission Directorate



<http://tinyurl.com/NASAECE> <http://tinyurl.com/NASA-14ECE> <http://tinyurl.com/NASA-15ECE> <http://tinyurl.com/NASA-16ECE>  
<http://tinyurl.com/NASAESE> <http://tinyurl.com/NASA-13ESI> <http://tinyurl.com/NASA-14ESI> [www.tinyurl.com/NASA-15ESI](http://tinyurl.com/NASA-15ESI) <http://tinyurl.com/NASA-16ESI>

## Eligibility Summary:

*Both ECF and ESI proposals must be submitted by accredited U.S. universities*

### Early Career Faculty

- PI must be recent Ph.D. (last 7 years)
- Untenured assistant professor and on tenure track
- U.S. citizen or permanent resident
- No co-investigators

### Early Stage Innovations

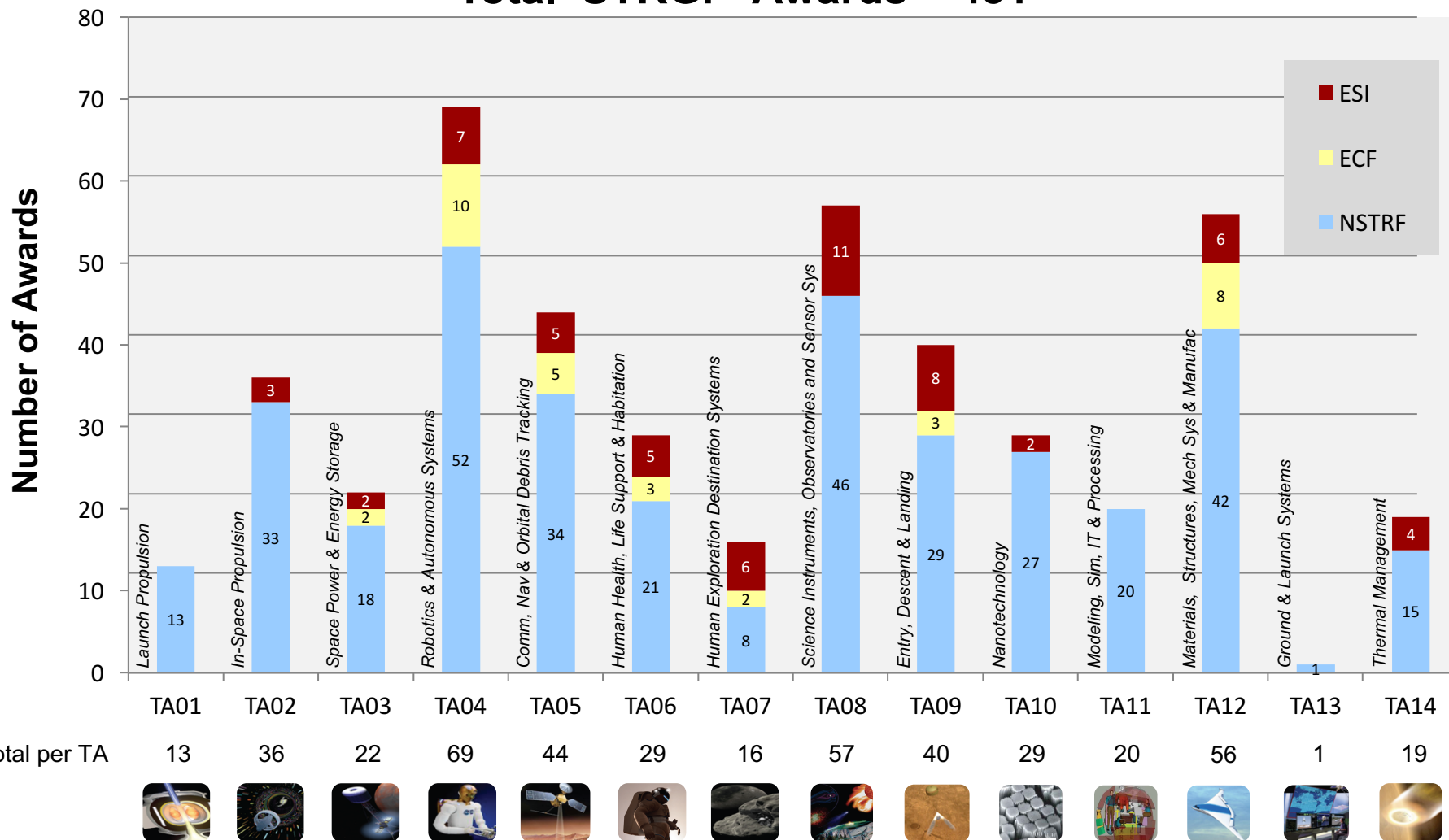
- PI must be from proposing university
- Co-investigators are permitted
- ≥ 50% of the proposed budget must go to the proposing university
- ≥ 70% of the proposed budget must go to universities

# STRG Portfolio - Awards To-Date

## Awards by Technology Area



**Total STRGP Awards = 451**



# STRG Highlights and Plans



**TA14- Corey Kruse, U Nebraska Lincoln:** Using Femtosecond Laser Processing to improve heat transfer on bare stainless steel and copper surfaces by nearly 7x over traditional materials.



**TA06- Heather Hava, CU Boulder:** Developed in situ food (plant) production systems for space exploration, relevant for long duration missions; Completed the design of an intelligent pot (SmartPOT) that can be remotely monitored and controlled.

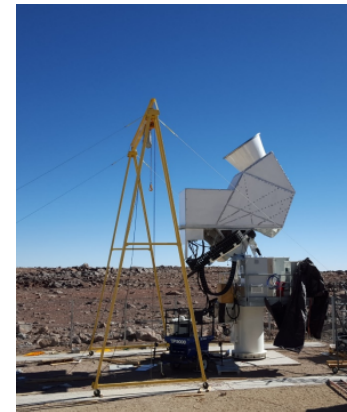


**TA12- Scott Zavada, U Michigan:** established the viability of using an in situ polymerizable liquid as an autonomic healing layer within a rigid structure, which was validated by ballistics testing.

**STRG is impacting all Technology Areas. Here are some examples.**



**TA04- Jennifer King, Carnegie Mellon:** Successfully expanded the types of tasks that can be performed by robots while reducing the need to hard-code task-specific action sequences. The algorithms use simple physics models (including estimates of friction, mass, etc.) to enable a robot to autonomously plan its interactions with the environment and perform manipulation tasks beyond just pick and place.

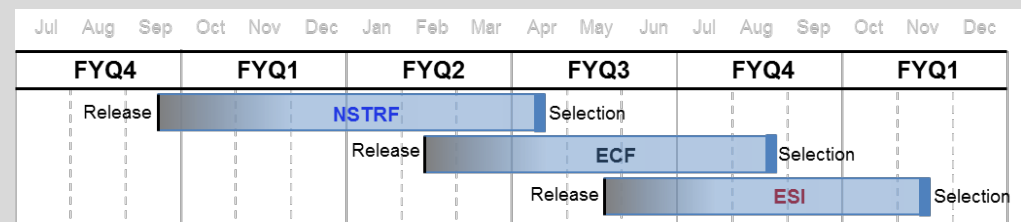


**TA08- Kathleen Harrington, Johns Hopkins:** successfully installed and operated Variable-delay Polarization Modulators (VPMs) on the Cosmology Large Angular Scale Surveyor (CLASS) telescope in Atacama, Chile.

## Recent Milestones

Solicitation	Date
NSTRF	11/3/2016: NSTRF17 applications due
ECF	10/1/16: ECF16 awards in place
ESI	12/2/16: ESI16 announcement

## Annual Solicitation Schedule





# NASA Innovative Advanced Concepts (NIAC) Program

Space Technology  
Mission Directorate

January 11, 2017

Jason Derleth  
Program Executive, NIAC  
[hq-niac@mail.nasa.gov](mailto:hq-niac@mail.nasa.gov)







# What is **NIAC**?

NASA Innovative Advanced Concepts

## *NASA Innovative Advanced Concepts*

A program to support  
early studies of  
innovative, yet credible,  
visionary concepts  
that could one day  
“change the possible”  
in aerospace.



# NIAC Awards, Scope, Criteria

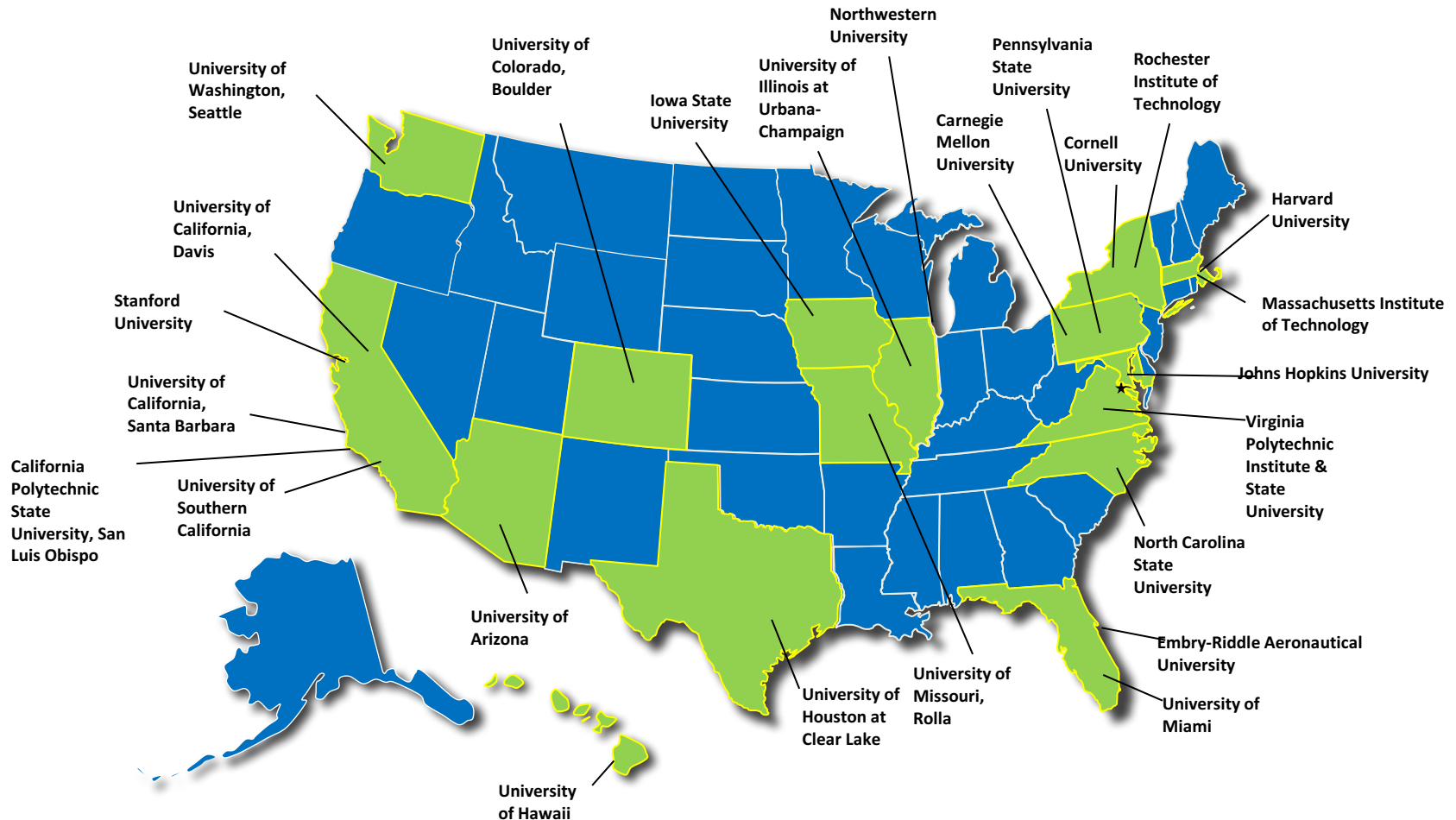


- NIAC awards support 2 phases of study:
  - **Phase I:** up to \$125K, ~9 months, for concept definition and initial analysis in a mission context
    - **Proposal Submission & Selection Process:** Two-step Process; Step A is fully- open; Step B by Invitation only; Independent Peer Review. (<https://www.nasa.gov/directorates/spacetech/niac/niac-phase-I-solicitation> )
  - **Phase II:** up to \$500K, 2 years, for further development of most promising Phase I concepts, comparative mission analysis, pathways forward
  - **Eligibility:** All categories of U.S organizations may apply. Non-U.S. organizations may partner in, or lead, NIAC studies on a no-exchange of funds basis, and subject to NASA's policy on foreign participation. **How to Apply:** (<https://www.nasa.gov/feature/how-to-apply-to-niac> )
  - **Goal:** Early studies of visionary aerospace architecture or mission concept
  - **Technology Readiness Level (TRL):** TRL 2 or lower at start of award
  - **NIAC Key Dates:** FY17 PhI Selections – 28 Mar '17 (Target); FY17 PhII NRA Released - 8 Dec '16; FY17 PhII Proposals Due – 3 Feb '17 (Target); (<https://www.nasa.gov/content/key-dates-and-solicitations>)
- Scope of NIAC Phase I Studies:
  - **Aerospace architecture or mission concepts** (not focused tech.)
  - **Exciting:** offering a potential breakthrough or revolutionary improvement
  - **Unexplored:** novel, with basic feasibility and properties unclear
  - **Credible:** sound scientific/engineering basis and plausible implementation
- NIAC proposal evaluation criteria:
  - **Potential of the Concept** (all scope elements above, especially exciting)
  - **Strength of the Approach** (research objectives, technical issues, suitability of team and cost)
  - **Benefits of the Study** (concept definition, mission analysis, wider benefits, scientific/engineering contributions, notably new/different/inspiring)

# NIAC Educational Institutions



## UNIVERSITY PARTNERS: Inspiring Our Nation's Innovators

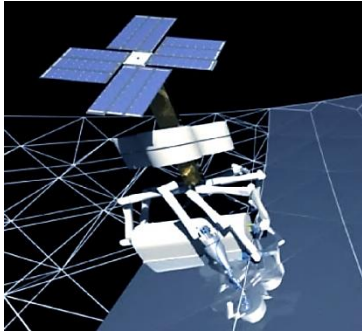




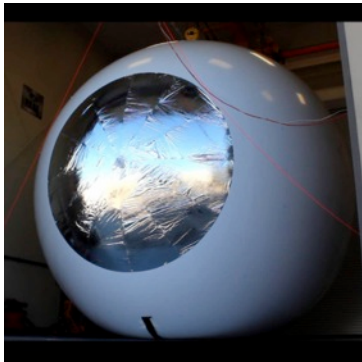
# NIAC Awards & Successes



## Notable Awards & Successes of NIAC Fellows



\$100M institute created for NIAC concept:  
Prof. Philip Lubin, University of California, Santa Barbara  
Private Funding - Directed energy interstellar work



Prof. Chris Walker, University of Arizona  
was testing his 10 Meter Sub-Orbital Large Balloon  
Reflector (LBR) in Antarctica with NASA

NIAC Fellow and NEC Member, Prof. Penny Boston was  
selected as NASA's new Director for Astrobiology at NASA  
ARC, effective May 31<sup>st</sup> 2016



Prof. Behrokh Khoshnevis, University of Southern  
California- Space Based Manufacturing First place award  
at the NASA In-Situ Materials Challenge

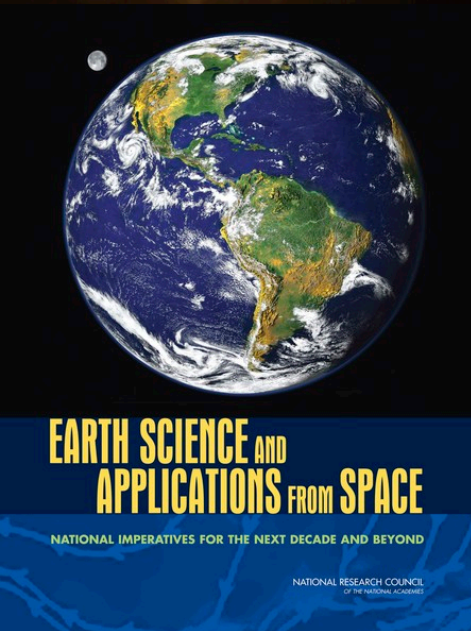
# SCIENCE Mission Directorate (SMD)



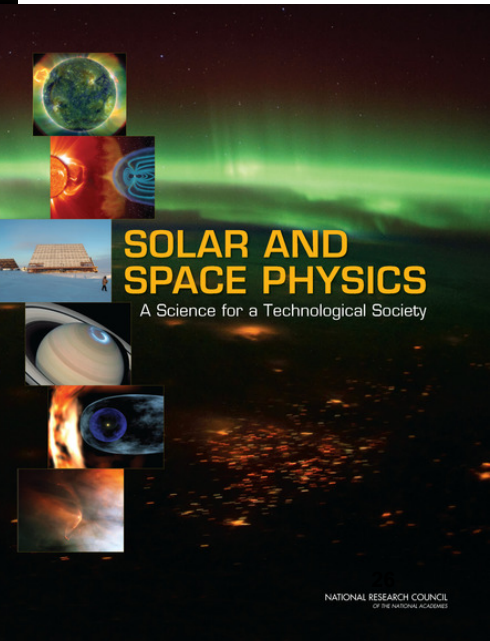
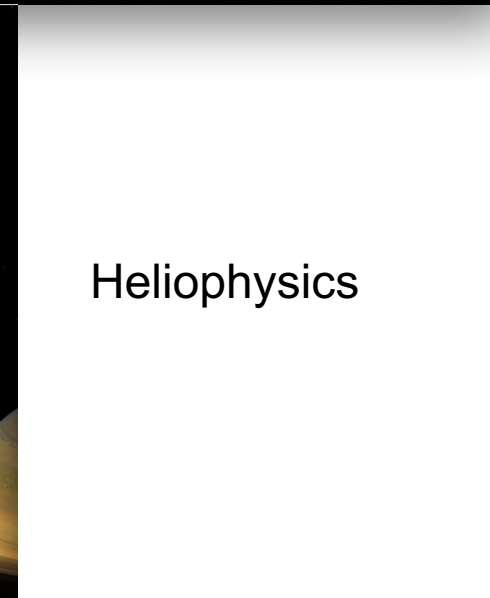
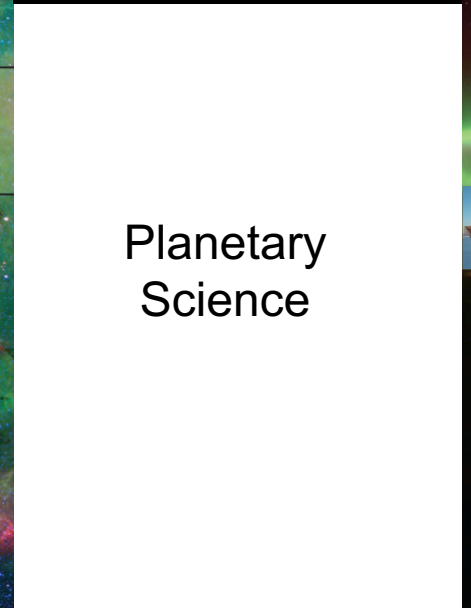
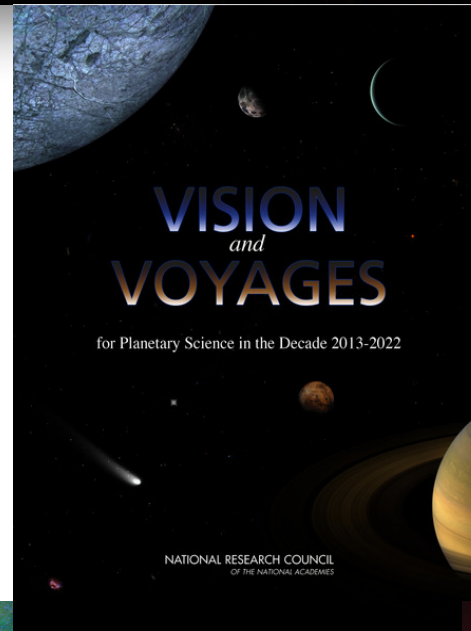
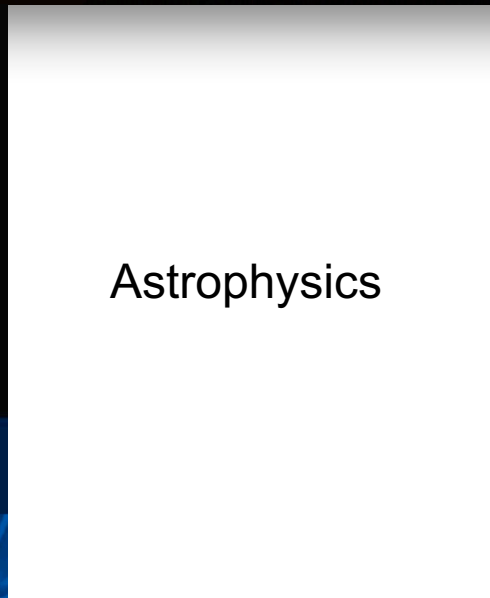
- The Science Mission Directorate develops and operates an overall program of science and exploration. Objectives include the following:
  - (1) study planet Earth from space to advance scientific understanding and meet societal needs;
  - (2) understand the Sun and its effects on Earth and the Solar System;
  - (3) advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space and
  - (4) discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets.

<https://science.nasa.gov>

# Science Divisions



Earth Science





# The Goals and Needs of SMD



SMD research and technology development must have science traceability to external roadmaps, reports and surveys:

- Strategy Documents
- Decadal Surveys
  - Every ten years, the four science communities gather panels of experts to set community-wide priorities for the coming decade. These surveys are facilitated by the National Academies and commissioned by the Federal agencies. The most recent surveys were completed between 2010 and 2013.

# SMD Funding Pathways



## SMD BY THE NUMBERS



**Spacecraft**  
105 missions\*  
88 spacecraft



**CubeSats**  
12 science missions\*  
11 technology demonstrations



**Balloon Payloads**  
13 science payloads  
13 piggyback/  
educational payloads



**Sounding Rocket Flights**  
14 science missions  
3 technology/educational  
missions



**Earth-Based Investigations**  
25 major airborne missions  
8 global networks



**Technology Development**  
~\$400M invested annually



**Research**  
10,000\* U.S. scientists funded  
3,000\* competitively selected awards  
~\$600M awarded annually

\*117 space-based missions

# SMD Solicitations



<https://science.nasa.gov/researchers/sara/grant-solicitations>

- Many solicitations are located at:  
<https://nspires.nasaprs.com>
  - Important group of Solicitations: Research Opportunities in Earth and Space Science (ROSES)\*
  - Set up NSPIRES account in advance and become familiar with the submission process.

\*Note: Previous solicitations are available



# Example Funding Opportunities



- Earth Science
  - The Instrument Incubator Program funds technology development (IIP)
- Planetary Science
  - Concepts for Ocean worlds Life Detection Technology (COLD-Tech)
- Astrophysics
  - Astrophysics Research and Analysis program (APRA)
- Heliophysics
  - Heliophysics Supporting Research (H-SR)



# How To Contact Us

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- **Email:** [sbir@reisystems.com](mailto:sbir@reisystems.com)